MARKETING RESEARCH REPORT NO. 635

PACKING MATURE GREEN TOMATOES:

QUALITY, COSTS, AND MARGINS IN THE LOWER RIO GRANDE VALLEY OF TEXAS

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FOREWORD

This report is the second of a series on market structure and pricing efficiency in the Lower Rio Grande Valley of Texas. The first report in the series was MRR 588, "Tomato Prices and Market Structure in the Lower Rio Grande Valley of Texas," by Joseph C. Podany and Raymond O. P. Farrish. Future reports will contain information on the structure, performance, or pricing efficiency of the tomato or other fresh fruit and vegetable markets. Relations between variations in market structure and pricing efficiency will be summarized in a final report.

William J. Cremins of the Marketing Field Office, Fruit and Vegetable Division, U. S. Agricultural Marketing Service, at McAllen, Tex., assisted in planning, initiating, and conducting the study. Frank Gross, Manager of the Texas Valley Tomato and Citrus Marketing Order Committees, Kenneth Martin, Manager of the South Texas Carrot Marketing Order Committee, and Kenneth Warden, Manager of the South Texas Lettuce and Onion Marketing Order Committees, assisted in obtaining the cooperation of shippers.

Many packers and shippers permitted work sampling observations and time studies in their plants during the packing season, and provided information on overhead and operating costs. Several builders and equipment dealers supplied information on replacement costs of sheds and equipment.

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Washington, D. C. November 1963

SUMMARY

The Lower Rio Grande Valley tomato market apparently performs efficiently in adjusting margins for changes in costs due to quality from one week to the next. The market performs somewhat less efficiently in adjusting margins over daily time periods.

We were interested in how Lower Valley shippers adjusted shipping-point margins to changes in costs due to changes in quality. The common trading practice in the Valley is to base price changes on a quarter cent per pound. Shippers must estimate packout when buying tomatoes, and variations within a quarter of a cent are probably as good as can reasonably be expected.

The daily and weekly weighted average f.o.b. price of all tomatoes sold by the sample shippers was compared to the daily and weekly weighted average price paid growers for tomatoes delivered to the packing shed "culls out." The difference was the shipping-point margin.

In general, margins decreased with better quality and increased when quality fell. Week-to-week changes in margins for a given percentage change in quality were closely related to the estimated change in packing costs. The estimated change in packing costs for an average efficiency shed was 0.54 cent per pound when quality decreased from 60 to 40 percent U.S. No. 1 grade. The estimated weekly change in margins for a comparable change in quality was 0.38 cent per pound. The difference was 0.16 cent per pound.

Day-to-day changes in margins were not as close to changes in packing costs. The change in the daily margin was estimated as .05 cent per pound for a change in quality from 60 to 40 percent U.S. No. 1 grade in an average shed. The difference between the change in margin and the change in packing costs was 0.49 cent per pound.

Estimates for both the packing line labor cost and all quality-associated packing costs were developed from observations made in several Lower Valley tomato packing sheds of varying efficiency. Packing costs per 60-pound equivalent of tomatoes packed were estimated for each shed observed. Costs of packing line labor for tomatoes running 60 percent U.S. No. 1 grade were 11 cents in a shed above average in efficiency compared to 15 cents in a shed below average in efficiency; comparable figures for all quality-associated costs were 52 and 73 cents.

For all the sheds observed in the study, costs of packing tomatoes increased as quality fell. As quality fell below 60 percent U. S. No. 1 grade, the effect on costs became quite large. This was true regardless of the efficiency of the individual sheds. For example, a shed operating at average efficiency had estimated packing costs that were one-half cent per pound higher at 41 than at 60 percent U.S. No. 1 grade.

PACKING MATURE GREEN TOMATOES: QUALITY, COSTS, AND MARGINS IN THE LOWER RIO GRANDE VALLEY OF TEXAS

by

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INTRODUCTION

The Lower Rio Grande Valley of Texas is a major commercial fruit and vegetable producing area made up of Willacy, Cameron, Hidalgo, and Starr Counties.

Harvest of mature green tomatoes in the Lower Valley starts in April and ends in June. Market prices often fluctuate considerably during this short period. From June 1 to June 16, 1962, for example, f.o.b. prices of U.S. No. 1 grade size 6 x 6 tomatoes rose from \$4.30 to \$6.00 per carton, an increase of 40 percent in 2 weeks. This marked price variability leads farmers, shippers, and others concerned with the industry to be especially interested in the pricing efficiency of the Lower Valley market.

This report discusses pricing efficiency of the market with respect to variations in quality of tomatoes. Pricing efficiency, as defined for this report, is the manner in which shippers adjust margins in response to changes in costs caused by quality variations. The shipping point margin is the difference between the weighted average price paid growers for tomatoes delivered to the packing shed "culls out" and the weighted average f.o.b. price of all tomatoes sold by the shippers.

Quality affects prices growers receive for tomatoes in two ways. First, poorer quality tomatoes, in comparison with better quality tomatoes, have proportionally less fruit of the higher priced grades and sizes or a higher percentage of cull tomatoes. Therefore, at given f.o.b. prices for each grade and size, the blend f.o.b. price for poorer quality tomatoes is lower, and hence the tomatoes are worth less at the farm. 2/ Second, poor quality tomatoes cost more to pack. With a given f.o.b. price for any grade, tomatoes of that grade are worth less at the farm level if they are part of a poor quality lot. In light of these considerations, one logically can expect prices received by growers to vary with changes in quality.

BUYING, PACKING, AND SELLING PRACTICES

Knowledge of common trading practices and the basic physical process of tomato packing is essential to understanding how shippers determine grower prices.

1/ Mr. Farrish transferred in April 1963 to the College of Agriculture, University of Arizona, as Extension Marketing Specialist.

2/ The term f.o.b. means the produce is placed free on board in "suitable shipping condition," and the buyer assumes all risk of damage and delay in transit not caused by the shipper. The buyer has the right of inspection at destination before the goods are paid for, but only for the purpose of determining that the produce shipped complied with the terms of the contract or order at time of shipment.

Shippers in the Lower Valley customarily buy mature green tomatoes "culls out, delivered to the shed." With the exception of culls, farmers are paid a certain price per pound for all tomatoes so delivered. This does not ordinarily mean that the farmer delivers the tomatoes to the packing shed. Shippers usually handle harvesting and hauling by contracting labor crews on a piece rate varying from $1.10 to $1.25 per hundred pounds gross weight. These charges are deducted from the amount paid growers after tomatoes are delivered to the shed.

The term "culls out, delivered to the shed," also does not describe the physical handling of culls. Shippers' contracts with harvest crews normally specify the maximum percentage of culls which may be delivered. Despite this, variable quantities of cull fruit virtually always reach the shed. Farmers are not paid for these culls. The weight of the culls is deducted from the gross weight of tomatoes delivered to the shed. The culls usually are disposed of by dumping, or are returned to the farm.

Packing mature green tomatoes is a fairly straightforward operation. Tomatoes are delivered to the shed in field boxes. The field boxes usually hold 48 pounds, although the larger 80-pound citrus box is also used. Upon delivery to the shed, the tomatoes are dumped on a moving belt by hand or mechanical means. The moving belt passes the tomatoes through a washer, dryer, and waxer and then through several grading stations. Pink and ripe tomatoes are usually removed and packed first. The next grading operation is for laborers to pick out cull tomatoes and place them on a belt or chute for transportation out of the plant. 3/ The third major grading operation is removal of U.S. No. 2 grade tomatoes, which go to separate sizing belts and packing stations. 4/ The remaining tomatoes, the U.S. No. 1 grade tomatoes, are then sized and packed.

Tomatoes are most commonly packed in 40-pound cartons. Other containers frequently used are the 60-pound wirebound crate, the 30-pound lug for handwrapped tomatoes, and the 20-pound flat. The packed containers usually move directly to weighing and closing stations, and then are transported by handtrucks or forklifts to a rail car or truck. In-shed storage is not a frequent practice.

Shippers buy individual lots of field-run tomatoes at a single price, but they sell tomatoes at different prices according to grade and size. The Federal Market News office in Weslaco, Tex., issues a daily report of f.o.b. prices by grade and size for various containers. These reports, plus reports from terminal markets, give shippers much price information to use in negotiating sales. Most sales are made by telephone.

The method by which shippers determine grower prices is illustrated in table 1. The f.o.b. prices for various grades and sizes of mature green tomatoes shown in column 3 of the table are merely assumed for illustration and do not represent any average price level. On the basis of their knowledge of f.o.b. prices, shippers deduct a constant unit packing cost (in table 1, assumed at $0.90 per 40-pound carton) and thus determine a break-even price for each grade and size (columns 4 and 5). Since all salable tomatoes in any lot are purchased at the same price, shippers must estimate the percentage of tomatoes in each grade and size category (column 2).

3/ The last workers grading are usually the most experienced, since the key spot in quality control is at the end of the line. From this position the last worker can determine whether the tomatoes being packed have too high or low a percentage of subgrade fruit. If too many poor quality tomatoes are being packed, for example, the last worker on the line can instruct other graders to cull more heavily.

4/ Lower Valley shippers usually use Federal grades. Federal marketing orders limit shipments not meeting specified Federal grades.

Table 1.--Hypothetical example of determining the "culls out, delivered to the shed" price of mature green tomatoes 1/

Grade and size (1)	Packout (2)	Price per 40-pound carton (3)	Packing cost per 40-pound carton (4)	Break-even price, culls out, delivered to the shed: By grade and size, per 40-pound carton (5)	Break-even price, culls out, delivered to the shed: Per pound (6)
	Percent	Dollars	Dollars	Dollars	Cents
U.S. No. 1					
6 x 6	40.6	3.30	.90	2.40	---
6 x 7	28.0	2.75	.90	1.85	---
7 x 7	1.4	2.00	.90	1.10	---
Total	70.0	---	---	2.15	---
U.S. No. 2					
6 x 6	17.4	2.30	.90	1.40	---
6 x 7	12.0	1.95	.90	1.05	---
7 x 7	0.6	1.25	.90	.35	---
Total	30.0	---	---	1.24	---
All grades and sizes	100.0	---	---	1.88	4.7

1/ To simplify the example, pinks and ripes are omitted.

On the basis of this estimate, the buyer determines the worth of the load of field-run tomatoes on a "culls out, delivered to the shed" basis (column 6).

The "culls out, delivered to the shed" price does not all go to the grower. Harvest and hauling still must be deducted. For example, assume that the "culls out, delivered to the shed" price is 4.7 cents per pound, harvesting and hauling charges are 1.1 cents per pound gross weight, and culls and 10 percent of gross weight. For 100 pounds field weight, there would be 90 pounds net weight, so the "delivered to the shed" return would be $4.23 (90 x $0.047). Deducting $1.10 for harvesting and hauling, the total net return to the grower would be $3.13, which is 3.1 cents per pound "culls in," or 3.5 cents per pound "culls out."

The above example illustrates a major reason why shippers generally prefer buying tomatoes "culls out, delivered to the shed," even though they arrange for harvesting. It simply is easier for shippers to determine the grower price on this basis than on a "culls in" basis. If shippers purchased tomatoes "culls in," they would have to allow for the percentage of culls in determining grower prices. Purchasing "culls out," they can separate any calculations concerning the percentage of culls and the harvest charges from those concerning price determination.

Not all Lower Valley shippers purchase tomatoes "culls out." A few buy tomatoes on a "field-run, delivered to the shed" basis, despite the greater difficulty of estimating packout. The reason generally given for this practice concerns relations with farmers. Conflicts may arise between shipper and grower over the estimation of culls if tomatoes are bought "culls out." A farmer may agree, say, to

sell for 4.7 cents per pound "culls out," but this price may be agreed upon with the expectation of a 90 percent packout. Should only 85 percent of the tomatoes be packed, the farmer may complain that the shipper culled too heavily to have a higher proportion of U.S. No. 1 grade tomatoes, and hence a higher average return f.o.b. Shippers who purchase "culls in" maintain that their method eliminates this source of conflict.

Regardless of whether purchases are "culls in" or "culls out," however, the basic nature of tomato packing imposes conditions which may result in conflict between growers and shippers. Both methods require an estimate of packout. Hence, some tomatoes must usually be dumped onto the packing line. Yet, once this happens, returning them to the truck would be impractical. Sufficient mutual trust must exist between grower and shipper for satisfactory terms to be reached. With either method of purchase, a limited time interval exists during which shippers accept delivery of a load of tomatoes without agreement on the total payment to the growers. This could mean that the total return might in some instances be insufficient to cover even harvest costs, but such cases are rare. A survey conducted for this study in 1961, for example, revealed no instance of Lower Valley farmers receiving less than harvest cost from cash buyers. This finding, of course, does not apply to situations in which shippers purchase fields of tomatoes prior to harvest. In such cases, the shippers already own the tomatoes, but in their bookkeeping they generally "charge" their packing operation for their own tomatoes. The price they charge is the average price paid for cash purchases on the harvest date. Thus, shippers can assess the profitability of field purchase and packing operations independently, on the assumption that an equivalent quantity of fruit could have been bought at the price they were paying on the harvest date. In this bookkeeping sense, therefore, even shippers accept their own tomatoes without knowing the total return to their field purchase operation.

THE EFFECT OF QUALITY ON COSTS AND MARGINS

The previous example of how Lower Valley shippers determine grower prices assumes that unit packing costs are constant regardless of quality. In reality, the basic nature of tomato packing virtually assures that costs will vary with quality. The speed of a tomato-packing line is governed by the maximum number of tomatoes workers can remove in any given time interval. For example, assume that two lots weighing 100 pounds each are dumped. If lot A has only 50 percent U.S. No. 1 grade tomatoes while lot B has 80 percent, workers on the grading tables have to handle more fruit with lot A than with lot B. Even though the tomatoes are packed as fast as possible, the lower quality lot A tomatoes will be packed at a slower rate or additional graders will be required. Usually line speed is adjusted, since changing the number of workers often means running into space and labor limitations. In determining the value of field-run tomatoes, therefore, consideration should be given to how packing costs vary with quality.

If wide variations in packing costs occur with changes in quality, a variable cost factor would more accurately reflect the value of field-run tomatoes. If the variations are small, using a constant packing cost should be adequate under most circumstances. Currently, most Lower Valley shippers disregard the effect of quality variations on packing costs except for relatively wide changes. This may be due to a lack of information concerning how quality affects packing costs. Most studies of packing costs take into account varying containers, capacity, and length

of packing season. Quality is usually assumed constant. 5/ Alternatively, shippers may have learned that quality variations have an appreciable impact on costs only in extreme cases. Information on how costs vary with quality, therefore, is important to shippers and growers alike in placing values on field-run tomatoes.

Methods

Work sampling and time study data were obtained from 9 tomato packing sheds in the Lower Rio Grande Valley during 1962. These firms were part of a larger group studied for a report on market structure and performance. 6/ They were selected for variations in capacity, layout, type of containers packed, and packing technologies.

Five to eight (usually seven) observations were made in each shed. The observations were spaced so that each packing shed was observed on several different hours of the day, days of the week, and weeks of the season (table 2). Observations were normally 2 hours in length, although some variation was necessary in a few cases.

During each observation, the volume of tomatoes dumped and the packout of tomatoes were recorded. Work sampling observations were made continuously of all workers on the packing line, including dumpers, graders, and packers. These observations provided a count of workers and an estimate of the proportion of time spent in various job elements. The basic data used in this analysis were the input of tomatoes in terms of total pounds dumped; the output by grade, size, and container; and the count of workers on the packing line. These data were used to determine relations between productivity per man-hour and quality of tomatoes.

Quality was measured in terms of the percentage of U.S. No. 1 grade tomatoes in the total weight of all tomatoes dumped. Costs can be expected to vary in response to changes in this measure because, with the exception of tomatoes removed by a sizer as not meeting minimum size requirements, all except the U.S. No. 1 tomatoes are handled by graders. Productivity was measured in terms of tomatoes packed per man-hour, whether U.S. No. 1, U.S. No. 2, pink, or ripe tomatoes. This measure of productivity was used because the total packout (not just the U.S. No. 1's) must bear all packing costs if the operation is to break even or make a profit. Thus, quality is expressed as a percentage of weight dumped and productivity is expressed in terms of weight packed. 7/

5/ An example of one study which did introduce quality explicitly was "Plum Packing Costs and Efficiency: The Effects of Packing Methods and Type of Container," by D. G. Stallings and L. L. Sammet, Mimeo Report No. 225, California Agricultural Experiment Station, Berkeley, December 1959. The authors indicated a 1,000-pound increase in fruit packed per hour required an additional one-third hour of grading labor, while a 1,000-pound increase in culls and over-ripes per hour required an additional two-thirds hour of grader labor.

6/ Podany, Joseph C., and Farrish, Raymond O. P. Tomato Prices and Market Structure in the Lower Rio Grande Valley of Texas. U. S. Dept. Agr. Mktg. Res. Rpt. 588, Feb. 1963.

7/ See Appendix A for information on how this affects the relation between quality and productivity.

Table 2.--Number of tomato packing sheds observed during hourly periods, by day of week, Lower Rio Grande Valley, May-June 1962

Period	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
A. M.						
10-11......	--	1	--	1	1	--
11-12......	--	1	--	1	1	--
P. M.						
12-1.......	--	--	--	--	--	--
1-2.......	1	1	1	2	1	1
2-3.......	2	3	3	4	2	2
3-4.......	3	6	3	4	4	2
4-5.......	2	6	3	4	3	3
5-6.......	2	3	1	2	3	3
6-7.......	--	1	--	1	2	--
7-8.......	2	3	4	4	3	1
8-9.......	2	3	4	4	2	1
9-10......	3	4	4	6	4	--
10-11......	2	1	3	3	3	--
11-12......	2	1	1	2	3	--
A. M.						
12-1.......	1	1	--	--	1	--
1-2.......	1	--	--	--	1	--
2-3.......	1	--	--	--	1	--

Estimation of Relation Between Quality and Productivity

Quality and productivity may be related by several methods, depending on the particular group of workers involved. The simplest assumption is that output is limited by the number of graders. With this assumption, a relation may be estimated between output per grader and quality of tomatoes (fig. 1). A second assumption is that different sections of the packing line may limit productivity when quality and volume change. If quality and output are high, dumpers and packers may limit productivity. If quality is poor, graders may limit output. On the basis of this assumption, a relation may be estimated between quality and output for all workers on the line (fig. 2).

Figures 1 and 2 reveal that a direct but imperfect relationship exists between quality and productivity in tomato packing. A major factor causing variation about the relation between quality and productivity is variation in the level of efficiency (output per worker) attained by different packing sheds. 8/ The sample sheds were selected to represent variations in operating methods; this alone would lead one to expect output per worker to vary between sheds even if quality were constant.

Variations in efficiency between sheds may take two forms. First, the change in output for a given change in quality may be different in different sheds. For

8/ Appendix A contains information on factors other than level of efficiency, which could explain part of this variability.

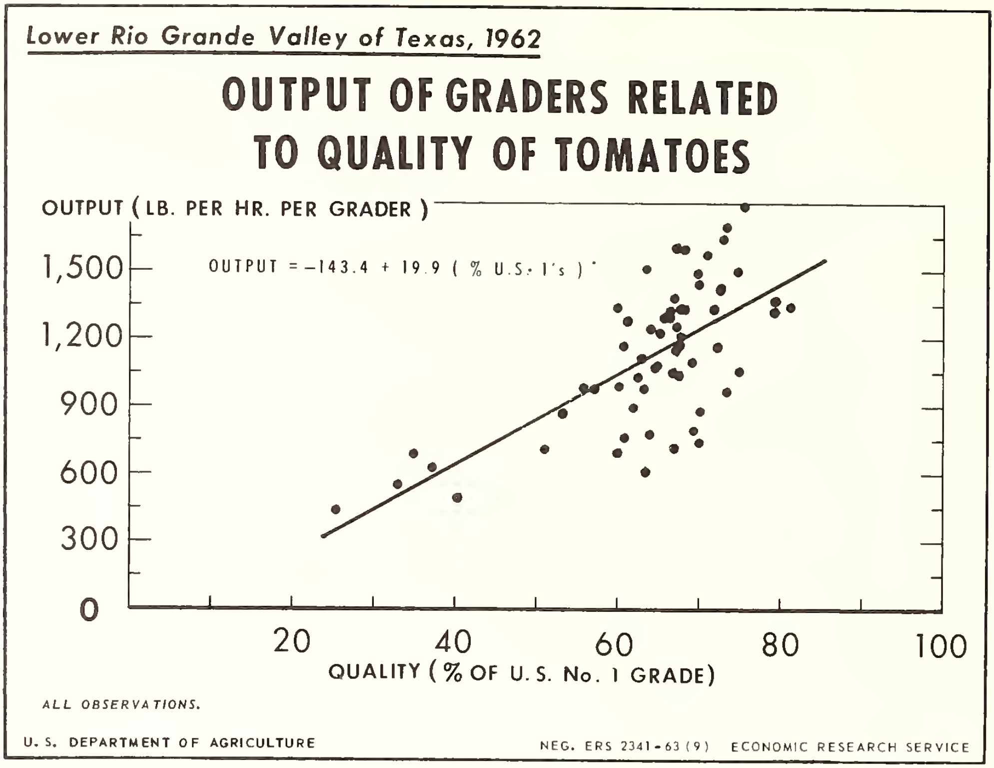

Figure 1

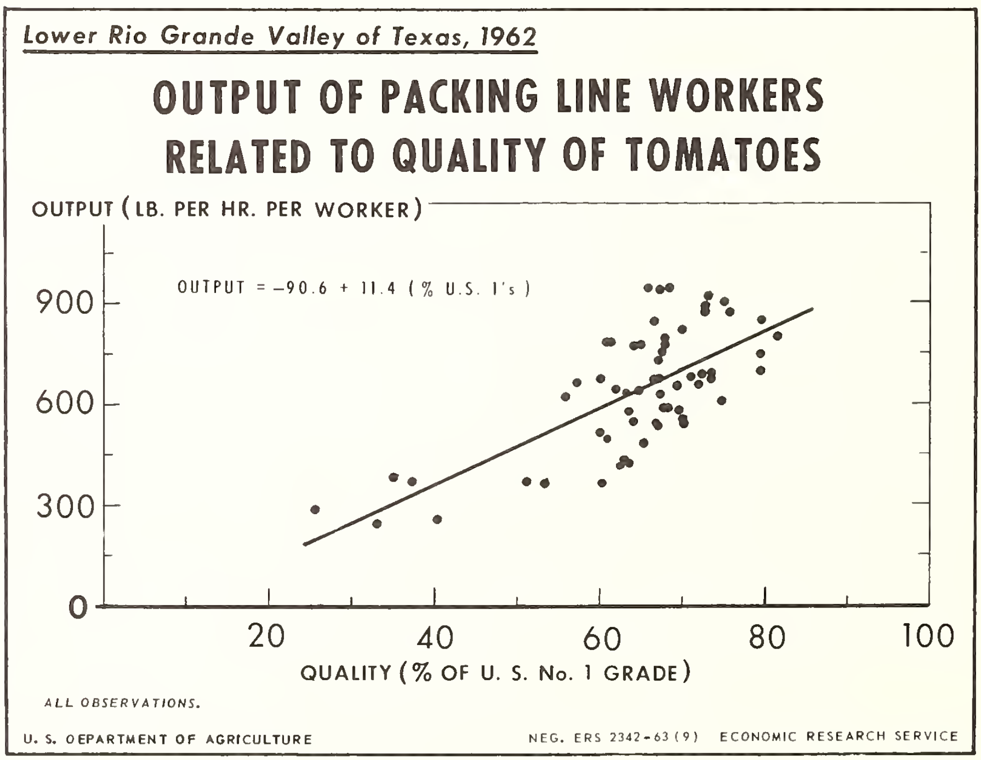

Figure 2

example, suppose quality of tomatoes increased by 10 percent in sheds A and B. Output per man-hour might increase by 120 pounds in shed A but only 100 pounds in shed B. Second, a 10-percent increase in quality might result in an increase of 100 pounds per man-hour in both sheds. But in the more efficient shed the increase might be from 800 to 900 pounds per man-hour, while in the less efficient shed it might be from 500 to 600. 9/

Statistical analysis of the data in figure 2 indicated that, with a given change in quality, output per man-hour changed by about the same amount in all sheds. Further analysis revealed that output per worker differed depending on the individual firms considered. 10/

On the average for all firms in the study, a 1-percent change in quality was associated with a 9.8-pound change in output per man-hour on the packing line. Hence, a 10-percent increase in quality would, on the average, raise output per man-hour on the packing line by 98 pounds. However, with quality at 60 percent U.S. No. 1 grade, output in the least efficient firm was approximately 480 pounds per man-hour and in the most efficient firm 765 pounds (fig. 3). When quality increased to 70 percent U. S. No. 1 grade, productivity increased approximately 98 pounds in each shed, that is, to 578 pounds per man-hour in the lowest shed and to 863 pounds in the highest. Thus, while productivity increased with improved quality in all sheds, some sheds had higher productivity than others for any given quality level.

Estimation of Relation Between Quality and Packing Cost

Since changes in quality of tomatoes change the output per man-hour by about the same amount for all sheds, the effect of quality on costs will be more pronounced with the firms operating at the lower levels of efficiency. 11/ Hence, the level of efficiency must be considered in analyzing the implications of quality changes on costs.

Output per man-hour on the packing line was estimated for three firms operating at different levels of efficiency and with tomatoes of varying quality (table 3). The

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9/ Stated mathematically, in the first example, the slope of the relation between productivity and quality would change between sheds, and in the second example, the slope of the relation would be the same but the value of the Y-intercept would differ.

10/ Results of an analysis of covariance indicated no significant difference at the 5-percent level between the sum of deviations around regressions for individual firms and the sum of deviations around regressions for individual firms using a common or "average" slope. Thus, there were no significant differences between firms in the amount by which output per worker changed when quality changed. Significant differences at the 1-percent level were found between the sum of deviations from individual firm regressions using a common or "average" slope and the sum of deviations from the total regression for all firms. Hence, there were significant differences in the level of efficiency between firms.

11/ For the purposes of this study, the level of efficiency for any particular firm is defined as the value of the Y-intercept for the regression line representing that particular firm in figure 3. Thus, the level of efficiency may be plus, zero, or minus, and the higher the value of the Y-intercept, the higher the level of efficiency. The use of this relatively simple definition is made possible by the choice of a common slope for each regression line.

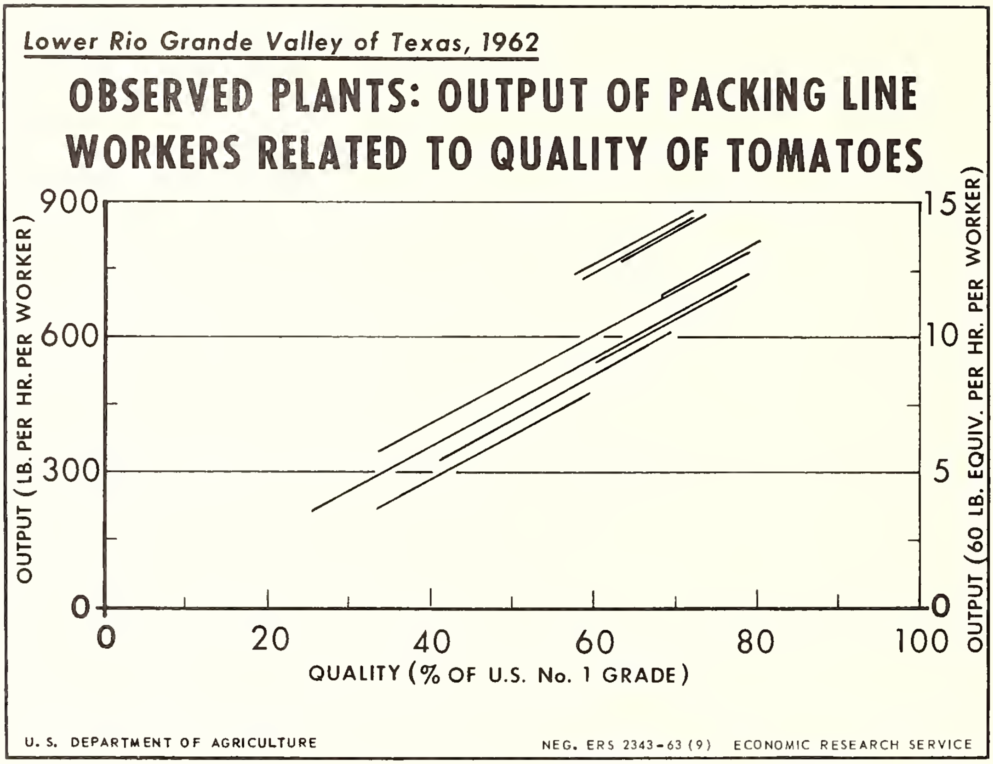

Figure 3

Table 3.--Output per man-hour on tomato packing lines under varying tomato quality and operating efficiency levels, Lower Rio Grande Valley of Texas, 1962

Quality (Percent U.S. No. 1 grade)	Output per man-hour on the packing line with an efficiency level --		
	Below average	Average	Above average
	Pounds	Pounds	Pounds
100	910	975	1,132
90	813	878	1,035
80	715	780	937
70	618	683	840
60	520	585	742
50	423	488	645
40	325	390	547
30	228	293	450

levels of efficiency correspond to the second lowest, the second highest, and the average outputs per man-hour actually observed in the sample sheds. From these figures, labor costs on the packing line may be estimated by applying appropriate labor costs, after an allowance has been made for rest periods and minor work stoppages (table 4). The most common wage rate in the Lower Valley was $1.15 per hour, plus 6 cents to cover Social Security and compensation benefits.

Table 4.--Packing line labor cost per 60-pound equivalent of tomatoes under varying tomato quality and operating efficiency levels, Lower Rio Grande Valley of Texas, 1962 1/ 2/

Quality (Percent U.S. No. 1 grade)	Packing-line labor cost per 60-pound equivalent of tomatoes packed with an efficiency level --		
	Below average	Average	Above average
	Cents	Cents	Cents
100	8.8	8.2	7.1
90	9.8	9.1	7.7
80	11.2	10.2	8.5
70	12.9	11.7	9.5
60	15.4	13.7	10.8
50	18.9	16.4	12.4
40	24.6	20.5	14.6
30	35.0	27.3	17.7

1/ 60-pound equivalent is 60 pounds of tomatoes regardless of type of container.
2/ Packing line labor includes all labor involved in performing the jobs of dumping, grading, and packing, but does not include such jobs as weighing, closing, stacking, box makeup, in-plant transportation, or loading or unloading trucks and rail cars. Costs were estimated by applying a wage cost of $1.21 per hour after reducing the table 3 estimates of output per manhour by 10 percent to allow for rest periods and minor work stoppages.

In addition to cost of packing line labor, costs for the following items have been assumed to vary when quality changes: Disposal of culls, shed labor, power for equipment, a portion of power for the shed, salaried labor, miscellaneous fixed costs, and fixed costs on building and equipment. 12/ For convenience, we will refer to the sum of these costs as "quality-associated costs." When they are taken into account, the effect of quality is more pronounced then when only packing line labor is considered (table 5).

Quality of tomatoes in the Lower Valley varies both within and between seasons (tables 6 and 7). Over the past 3 years, the seasonal average quality has probably varied between 55 and 63 percent. An efficient pricing schedule may be developed so as to reflect grower price differentials of one-tenth cent per pound. Such a schedule was developed in table 8 with a "normal" quality of 60 percent and with packing costs varying as estimated in table 5. For example, for a shed operating at average efficiency, costs are estimated to be 0.1 cent less at 66-percent quality than at 60-percent quality. Hence, for any given load, the tomatoes of 66-percent quality would be "worth" 0.1 cent more delivered to the shed than those of 60-percent quality. Alternatively, costs of packing 51 percent U.S. No. 1 grade tomatoes are approximately 0.2 cent higher than for average quality, and hence these tomatoes are worth 0.2 cent per pound less delivered to the shed.

12/ Fixed costs on buildings and equipment are depreciation, interest, repairs, taxes, and insurance. The classification of costs which are affected by quality raises several important and interesting problems, both practical and theoretical. Appendix B contains a discussion of these problems and the reasons the particular cost factors listed above were chosen in this study.

Table 5.--Estimated quality-associated costs, under varying tomato quality and operating efficiency levels, Lower Rio Grande Valley of Texas, 1962 1/

Quality (Percent U.S. No. 1 grade)	Quality-associated costs with an efficiency level --					
	Below average		Average		Above average	
	Cents per 60 pounds	Cents per pound	Cents per 60 pounds	Cents per pound	Cents per 60 pounds	Cents per pound
90	46.3	.77	43.0	.72	36.4	.61
80	53.0	.88	48.5	.81	40.5	.68
70	61.4	1.02	55.6	.93	45.4	.76
65	66.8	1.11	59.9	1.00	48.2	.80
60	73.1	1.22	65.2	1.09	51.5	.86
50	89.9	1.50	78.2	1.30	59.5	.99
40	117.2	1.95	97.8	1.63	70.2	1.17
30	166.7	2.78	129.8	2.16	85.3	1.42

1/ Quality-associated costs include cull disposal; shed labor; power for equipment; a portion of power costs for the building; and fixed costs on buildings, equipment, salaried labor (includes fieldmen, salesmen, shed managers, office personnel, and administration), and miscellaneous fixed costs. Costs not included are constant per unit of packout, for example, container costs and committee assessments. Cost figures are based on a medium-sized shed running 200 hours, packing cartons and wirebound crates, and employing 54 shed workers, including 34 on the packing line.

Table 6.--Total tomato shipments from the Lower Rio Grande Valley, and proportion of shipments and total harvest by grade, 1960, 1961, and 1962 1/

Grade	60-pound equivalents 2/			Proportion of shipments			Estimated proportion of total harvested		
	1960	1961	1962	1960	1961	1962	1960	1961	1962
	No.	No.	No.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
U.S. No. 1	586,627	940,342	1,191,434	65	66	72	54	55	63
U.S. No. 2	275,329	379,590	355,264	30	26	22	26	22	19
Pinks	42,080	115,249	103,426	5	8	6	4	7	5
Total shipments	904,036	1,435,181	1,650,124	100	100	100	84	84	87
Estimated culls	170,913	266,452	246,987	--	--	--	16	16	13
Estimated total harvested	1,074,949	1,701,633	1,897,111	--	--	--	100	100	100

1/ Shipment data provided by Texas Valley Tomato Committee. Cull data estimated on assumption, based on observations in sample sheds, that culls equal 35 percent of the weight of all non-U.S. No. 1 grade tomatoes.
2/ 60 pounds of tomatoes regardless of type of container.

Table 7.--Frequency distribution of tomato quality observed during plant efficiency study, 9 sheds, Lower Rio Grande Valley, 1962

Quality (Percent U.S. No. 1 grade)	Frequency	Proportion
	Number of observations	Percent
0.0 to 10.0	0	0.0
10.1 to 20.0	0	0.0
20.1 to 30.0	1	1.6
30.1 to 40.0	3	4.8
40.1 to 50.0	1	1.6
50.1 to 60.0	6	9.7
60.1 to 70.0	36	58.1
70.1 to 80.0	14	22.6
80.1 to 90.0	1	1.6
90.1 to 100.0	0	0.0

Table 8.--Price differential schedule to account for variations in packing costs due to quality changes in tomatoes 1/

Price differential (cents)	Quality level at which price differential of 0.1 cent per pound would be applied, with an operating efficiency level --		
	Below average	Average	Above average
	Percent U.S. No. 1	Percent U.S. No. 1	Percent U.S. No. 1
+0.20	70	73	82
+0.10	65	66	70
0.00	60	60	60
-0.10	56	55	53
-0.20	53	51	47
-0.30	50	47	41
-0.40	47	44	36
-0.50	45	41	32
-0.75	40	36	25
-1.00	37	31	19

1/ Based on differences in packing costs as presented in table 5.

Most of the price differentials which could be applied are at quality ranges below 60 percent U.S. No. 1 grade. Tomatoes would have to reach 73 percent U.S. No. 1 grade, 13 percent above average, to justify a price 0.2 cent higher, with average efficiency levels. In only 9 of 62 observations made in the sample plants was quality above 73 percent. For quality ranges below 60 percent, price adjustments of 0.1 cent could be made more frequently. For example, for a shed of average efficiency a quality decrease to 55 percent would lower grower prices by 0.1 cent. Another 4-percent quality decrease, to 51 percent, would decrease grower prices another 0.1 cent.

As quality declined below 51 percent, the effect on costs and price differentials would be even more pronounced. Costs would be 0.5 cent per pound higher, and grower prices 0.5 cent per pound lower, with 41-percent quality than with 60-percent quality.

Thus, quality variations have a dual effect on prices growers receive for tomatoes. First, poorer quality tomatoes are worth less f.o.b. Second, poor quality tomatoes cost more to pack. It should be emphasized that the price differentials in table 8 account for packing costs only, and not the change in value f.o.b.

IMPLICATIONS OF QUALITY VARIATIONS ON SHIPPING POINT MARGINS AND PRICING EFFICIENCY

Quality variations affect returns to growers both through changes in packing costs and changes in value f.o.b. They also can affect shipping-point margins in many different ways. In particular, we would expect margins to vary with quality because of the effect of quality on packing costs. When assessing pricing efficiency, therefore, we are interested in determining the answer to these questions: (1) Do margins vary with quality? (2) How long does it take for margins to adjust to changes in quality? (3) Are changes in margins associated with quality of the same magnitude as changes in packing costs associated with quality?

Data on shipping point margins were collected from a sample of 12 Lower Valley tomato shippers handling approximately 49 percent of all tomatoes shipped during the 1961 season. Information was recorded on all purchases and sales of tomatoes. From these data, it was possible to estimate shipping point margins, quality of tomatoes, and the proportion of the tomatoes packed in various containers.

Two multiple regression equations were computed to estimate how margins varied with changes in quality over different lengths of time. 13/ The time periods

13/ A multiple regression equation is a statistical technique which estimates the effect of an independent variable (in this case quality) on a dependent variable (margins) on the assumption that other factors affecting the dependent variable are held constant or are randomly distributed. The equations for which results are presented in the text were of the type:

$$Y_i = a_i + X_{1i}^{b1i} + b_{2i} X_{2i}$$

where

Y = margins in dollars per 60-pound equivalent;

X_1 = quality, expressed as percent U.S. No. 1 grade in all tomatoes dumped;

X_2 = percentage of packout which was hand-packed; and

i = the time interval on which observations are based.

These equations, curvilinear for X_1 and linear for X_2, closely correspond to the nature of the packing costs associated with quality (table 5) and packing tomatoes in lugs (Appendix A). Several other statistical equations were estimated. See Appendix C for equations not discussed here.

chosen were daily and weekly intervals. Results of these equations were:

$$Y_D = 1.236 + X_{1,D}^{-.166} + 2.798\, X_{2,D}$$
$$(R = .673)$$

$$YW = .364 + X_{1,W}^{-1.324} + 2.531\, X_{2,W}$$
$$(R = .862)$$

where

Y_D = the daily average shipping-point margin in dollars per 60-pound equivalent,

$X_{1,D}$ = daily average quality, expressed as percent U.S. No. 1 grade in all tomatoes dumped,

$X_{2,D}$ = the daily average percentage of packout which was hand-packed,

Y_W = the weekly average shipping-point margin, in dollars per 60-pound equivalent,

X1,W = weekly average quality, expressed as percent U.S. No. 1 grade in all tomatoes dumped, and

$X_{2,W}$ = the weekly average percentage of packout which was hand-packed.

The results of both equations show that variations in shipping-point margins are associated with changes in quality, poor quality being associated with higher margins. Thus, in assessing pricing efficiency, the answer to question 1 seems established; for 1961, at least, margins varied with quality.

The answer to question 3 depends to a great extent on the answer to the second question. Changes in margins from week to week were much closer to changes in costs than were daily changes in margins (table 9). When quality changed from 60 to 40 percent U.S. No. 1 grade, for example, costs increased 0.74 cent per pound in sheds operating at below average levels of efficiency, 0.54 cent per pound in sheds of average efficiency, and 0.31 cent in sheds of above average efficiency. For the same change in quality over a 1-day period, margins increased 0.05 cent. When quality changed from 60 percent for 1 week to 40 percent for another week, margins increased by 0.38 cent.

In general, quality changes from 1 week to the next over an interval of 80 percent to 40 percent result in estimated changes in shipping-point margins per pound that are within a quarter to a half cent of the changes in packing costs per pound. On a week-to-week basis, therefore, changes in margins seem reasonably close to changes in costs. In comparison, daily changes in margins associated with quality, while statistically significant, were very small. When quality changed from 60 to 40 percent, for example, daily margins changed less than 0.1 cent per pound. This change is insignificant for most practical purposes.

In assessing pricing efficiency, it is unrealistic to insist that margins vary within 0.1 cent per pound of costs before classifying market performance as efficient. Cost changes presented are only estimates, and will vary from shed to shed. Also, under operating conditions shippers do not consider price changes of less than 0.1 cent per pound. The most common basis for price changes is a quarter of a cent.

Table 9.--Comparison of estimated changes in costs and margins associated with quality changes in tomatoes, Lower Rio Grande Valley of Texas

Change in quality from 60-percent U.S. No. 1 grade to --	Change in packing costs, 1/ for firms with an operating efficiency level --			Change in margins 2/	
	Below average	Average	Above average	Day-to-day	Week-to-week
	Cents per pound	Cents per pound	Cents per pound	Cents per pound	Cents per pound
90 percent....	-0.45	-0.37	-0.25	-0.05	-0.39
80 percent....	-0.34	-0.28	-0.18	-0.03	-0.28
70 percent....	-0.20	-0.16	-0.10	-0.02	-0.15
50 percent....	.28	.21	.13	.02	.17
40 percent....	.73	.54	.31	.05	.38
30 percent....	1.56	1.07	.56	.08	.67

1/ Derived from table 5.
2/ Based on the relationship between quality and margins during the 1961 season as estimated from multiple regression equations.

Shippers must estimate packout when buying tomatoes, and there is a limit to how precise this estimate can be. Variations within a quarter cent, therefore, are probably as good as can reasonably be expected, given common trading practices.

While changes in margins were not precisely equal to changes in costs, the data presented in table 9 give substantial evidence that shippers vary margins with changes in quality, at least over weekly periods. Further, while differences between estimated cost changes and changes in margins due to quality may at first seem large, they appear more reasonable when common trading practices are taken into account.

In summary, both daily and weekly average margins varied with quality during the 1961 season. Higher margins were associated with poorer quality. The magnitude of changes in margins on a weekly basis was reasonably close to the magnitude of changes in costs when common trading practices are considered. The magnitude of changes in daily margins was not as close. Thus, it appears that Lower Valley shippers perform efficiently in adjusting margins to changes in quality over time periods of about a week, but less efficiently over daily periods.

APPENDIX A

FACTORS INFLUENCING THE RELATION OF PRODUCTIVITY TO QUALITY

The level of efficiency attained by different packinghouses explains a significant part of the variability about the relation between productivity and quality. (See text, figs. 2 and 3 and footnote 10). Four other factors were examined to determine whether they contributed to the observed variations: Lags in adjusting the speed of the line to quality changes; changes in the average size of tomatoes packed; the proportion of tomatoes hand-packed in lugs; and the method used to measure quality and productivity.

Under actual operating conditions, time lags frequently occur in adjusting packing line speed to changes in quality. One possible method of accounting for this factor is to eliminate all nonproductive time from the basic data. 14/ This adjustment was made on the basis of work sampling observations and a linear regression computed on the revised data.

The revised equation was:

$$\text{Pounds output per grader per hour excluding nonproductive time} = -101.8 + \underset{(6.709^{**})}{20.3(X)}$$

$$R^2 = .43$$

where X = percent U.S. No. 1's in total quantity dumped.

The equation for the original data (also presented in the text figure 1) was

$$\text{Pounds output per grader per hour} = -143.4 + \underset{(7.259^{**})}{19.9(X)}$$

$$R^2 = .47$$

Figures in parentheses are t-values which test the significance of coefficients.

On the basis of statistical reliability, the revised equation not only does not offer any significant improvement but is in fact poorer. Eliminating all nonproductive time in estimating productivity of graders does not improve the fit. With such results, the use of revised data would be difficult to justify, since it would take the observations further from operating reality without any compensating gain.

Changes in the size of tomatoes packed may also affect the relation between productivity and quality, and may have been a source of bias in the data. In estimating weight dumped and packed during any 2-hour observation, it was necessary to count containers and field boxes and then apply factors for weight per box. It was reasonable to assume the weight of any particular container was constant, since packed containers are usually weighed on the packing line. The weight of field boxes was probably more variable, however, and weights may have varied somewhat according to the average size of tomato. If tomatoes were running exceptionally small, a field box might weigh more than average. Thus, the output of U.S. No. 1 grade tomatoes as a percentage of pounds dumped could be overstated if an average weight per field box is assumed.

Adjustments in the data to account for variations in size had virtually no effect on any of the observations (table 10). The difference between adjusted and unadjusted data was so small that further investigation of this source of variation was not warranted.

Changes in the proportion of tomatoes hand-packed undoubtedly affect packing costs. They also undoubtedly affect productivity. It takes longer to wrap and place-pack 60 pounds of tomatoes in lugs than it does to jumble-fill a wirebound crate.

14/ The nonproductive time referred to in this adjustment is the estimated time a grader is idle while the line is running. This time was estimated from work sampling observations made of graders in the sample sheds. The elements used in this work sampling were "work," "inspect" and "idle." Nonproductive time arising from complete stoppage of the line was not included in the basic data.

Table 10.--Observations of output per man-hour on the packing line, original and adjusted for variations in size, 9 sample tomato packing sheds, Lower Rio Grande Valley, 1962 1/

Output per man-hour		Output per man-hour	
Original	Adjusted	Original	Adjusted
Pounds	Pounds	Pounds	Pounds
552	545	609	618
543	548	723	733
399	405	588	588
454	461	1,073	1,086
377	367	946	944
723	719	936	934
675	706	774	786
671	685	806	787
681	657	868	870
554	539	981	982
698	710	612	609
726	714	675	675
1,132	1,107	708	708
925	919	740	734
585	587	722	727
649	652	549	544
908	864	442	448
764	763	913	888
515	531	707	707
682	711	784	766
690	684	859	862
565	565	914	928
589	593	919	927
726	733	812	831
331	331	833	823
545	541	953	907
676	676	997	1,000
656	636	1,069	1,075
587	586	1,244	1,265
758	748	1,127	1,155
621	633	1,042	1,053

1/ Output measured as pounds dumped. The weight per cubic inch of tomatoes was .3084 for 7 x 7's, .3056 for 6 x 7's, .2477 for 6 x 6's and larger. The weighted average density for field boxes dumped for each observation was compared with the average density for all observations in a shed. The average density for all observations was assumed to be comparable to the composition of the average field box dumped. The pounds dumped for individual observations could be adjusted on the basis of field box weights for each observation.

Estimates of the variation in productivity due to packing in lugs, however, should be viewed with some caution because only 4 of the 9 sample sheds packed lugs during any of the observations. The results of a multiple regression analysis were:

$$Y = 74.4 + 9.18\ (X_1) - 3.4\ (X_2)$$

$$(8.47\ ^{**}) \qquad (4.66\ ^{**})$$

$$R^2 = .56$$

where

Y = productivity, in terms of output per man-hour for all workers on the line,

X_1 = quality, expressed as the percentage of U.S. No. 1 grade,

X_2 = the proportion of tomatoes hand-packed.

Figures in parentheses are t-values for the corresponding coefficients.

The sign of the "hand-packed" variable was as expected, that is, an increase in the proportion hand-packed was associated with a decrease in productivity. The coefficient of X_2 (-3.4) would indicate that an increase of 10 percent in the proportion hand-packed was associated with a decrease of 34 pounds in production per man-hour. The t-value indicates that the coefficient is significantly different from zero at the 99 percent level of probability. More detailed information on cost variations associated with containers will be developed in a future research report.

The relation between productivity and quality may also be influenced by how productivity and quality are measured. In this report, quality was expressed as a percentage of weight dumped and productivity was expressed in terms of weight packed. This is not inconsistent, although the weight dumped includes the culls and is greater then the weight packed. If productivity was expressed in terms of the weight dumped it would still vary with quality. Basing productivity on packout would emphasize the relation, because packout for any lot is a function of quality. As the percentage of culls goes up (that is, as quality goes down) both packout and productivity go down.

This reasoning assumes that the percentage of U.S. No. 1 grade tomatoes and the percentage of culls are equivalent (and inverse) measures of quality. This assumption is not strictly correct; a perfect correlation does not exist between percentages of culls and of U.S. No. 1 grade tomatoes. Analysis of the relation between the two for the sample plants, however, showed a good correlation (-.7). Substitution of the percentage of culls for the percentage of U.S. No. 1 grade would not substantially affect the results.

The use of actual packout emphasized the relation between output and productivity, and made the results more readily evident. In light of the difficulty in obtaining data for measuring this relation, the availability of such an analytical device was helpful.

APPENDIX B

COST FACTORS INFLUENCED BY QUALITY CHANGES

The following classification of cost factors is useful in determining costs affected by quality variations:

1. Costs directly related to the amount of cull fruit disposed of.

2. Costs directly related to the number of hours the shed operates. Examples are shed labor, and some repairs and utilities.

3. Costs directly related to the number of containers packed. Examples are container costs and marketing order committee assessments.

4. Costs incurred annually regardless of the number of containers packed, hours operated, or amount of culls. Examples are interest on investment and property taxes.

Since the amount of culls depends on quality of the tomatoes dumped, costs associated with the volume of culls will vary with changes in quality. Therefore, costs will be higher with poor quality fruit because both the cost of cull disposal will be higher and because the packout will be smaller. Cull disposal is, therefore, considered a quality-associated cost in this analysis. Costs of cull disposal were estimated at 0.1 cent per pound of culls. Culls were estimated as a linear function of quality: Percent culls = 0.35 (100 = percent U.S. No. 1 grade). This function was based upon observations made in the sample plants.

Costs directly related to the number of hours a shed operates will also vary with quality. Quality influences costs through limiting the volume packed in any given hour. With lower quality tomatoes, therefore, either output in a day will be lower, or a longer number of hours will be worked. In either event, those costs which are related to the hours of operation will increase. Therefore, costs directly related to the number of hours a shed operates are considered as quality associated costs in this analysis. Factors included in this category were: All shed labor, variable equipment costs (power and repairs), and miscellaneous utilities. The level of costs for these factors was estimated on the basis of observations in the sample sheds, information supplied by equipment dealers, and utility rates in the Valley.

Costs directly related to the number of containers packed will by definition remain constant per unit of output regardless of how quality and volume change. In actual circumstances, there are few if any cost categories which can be presumed constant over complete volume ranges. Nevertheless, some costs are sufficiently close to this hypothetical ideal to warrant treatment as constant per unit in most circumstances. These costs were therefore considered as not influenced by quality for the purposes of this analysis. Items included in this category were containers, inspection fees, marketing order committee assessments, waxing and chlorine treatments, and part of telephone and telegraph charges. Since the per unit cost of these items would not vary with quality, their level was not estimated for this study.

Quality will affect costs which are a fixed aggregate amount per year. With a given quantity of tomatoes delivered to the shed, the total packout will decrease with poorer quality. Hence, the fixed annual charges must be spread over fewer units of output, and unit costs will rise. In actual circumstances quality may have an even more pronounced effect on fixed costs. Tomatoes usually are delivered to

the shed as long as growers can cover harvest costs. With poorer quality there is the chance that fewer tomatoes will be delivered to the shed, thus further reducing packout and increasing unit costs. Fixed costs include depreciation, insurance, repairs, taxes and interest on buildings and equipment, all salaried labor, and miscellaneous annual fixed expenses. With tomatoes of 65 percent U.S. No. 1 grade, the level of these costs was estimated at 33.81 cents per 60-pound equivalent packed. The estimates were derived by budgeting techniques, and are based on a shed operating 200 hours per year and packing 220 carlot equivalents. 15/

APPENDIX C

THEORETICAL AND STATISTICAL CONSIDERATIONS IN RELATING MARGINS TO QUALITY

Quality affects packing costs in a curvilinear fashion. The effect of quality on costs becomes proportionately greater as quality becomes lower (see text, table 5). If shipping point margins vary with costs, the relation between margins and quality should also be curvilinear.

Costs also vary with the containers tomatoes are packed in. If shippers adjust margins for cost differences caused by quality, it is logical to assume they adjust margins for differences due to containers. A variable representing the proportion of tomatoes hand-packed should, therefore, be included in statistical estimates of variations in margins.

Table 11 shows the effect of quality on margins as estimated by several regression equations in addition to the ones used for the estimates in table 9 of the text. All equations estimated were of the general form:

Margins = f (percent U.S. No. 1 grade, percent hand packed).

Equations were computed linear for both variables (type 1), curvilinear for both variables (type 2), and curvilinear for quality but linear for percent hand-packed (type 3). Linear equations (type 1) were included to test whether the simplest hypothesis (linearity) "explained" as much variation in margins as more complicated (curvilinear) hypotheses.

Equations were computed with all variables measured as daily averages (types 1a, 2a, and 3a), 3-day averages (types 1b, 2b, and 3b), weekly averages (types 1c, 2c, and 3c), and 2-week averages (types 1d, 2d, and 3d). These different time periods were used to test the hypothesis that shippers make better adjustments to quality changes over longer time periods.

There is little reason to choose curvilinear forms in preference to the simple linear form, on the basis of multiple correlation coefficients and significance of b-values. With the exception of equations for daily averages, correlations were all reasonably high, and most b-values were significant at the 95 or 99 percent levels.

Multiple correlation coefficients were highest for 2-week equations (types 1d, 2d, and 3d) and lowest for daily equations (1a, 2a, and 3a). The absolute values of b_1-coefficients generally increased with longer time periods. These results are

15/ A "carlot equivalent" of tomatoes is equal to 500 60-pound wirebound crates, or their equivalent.

Table 11.--Regression and correlation coefficients, t-values, and degrees of freedom for multiple regression equations, relating margins (Y) to quality (X_1) and percent hand packed (X_2), Lower Rio Grande Valley tomato market, 1961

Equation	Statistical model	Time interval	b_o	b_1	b_2	t_1	t_2	R	d.f.
1a.......	$Y = a + b_1X_1 + b_2X_2$	1-day	2.179	-1.599	2.654	2.226*	5.819**	0.673	52
1b.......	"	3-days	2.608	-2.649	2.651	2.171**	5.954**	0.893	18
1c.......	"	1-week	3.074	-3.665	2.604	2.385**	3.410**	0.881	8
1d.......	"	2-weeks	2.776	-3.352	2.885	2.116	3.787*	0.953	3
2a.......	$Y = a + X_1^{b_1} + X_2^{b_2}$	1-day	2.337	- .192	.171	2.013*	2.242*	0.366	52
2b.......	"	3-days	1.389	-1.348	.189	3.185**	2.403*	0.714	18
2c.......	"	1-week	.575	-2.482	.262	4.636**	3.607**	0.892	8
2d.......	"	2-weeks	.258	-2.746	.244	6.773**	5.443**	0.978	3
3a.......	$Y = a + X_1^{b_1} + b_2X_2$	1-day	1.236	- .166	2.798	2.212**	6.186**	0.673	52
3b.......	"	3-days	.746	- .776	2.723	2.442**	5.607**	0.874	18
3c.......	"	1-week	.364	-1.324	2.531	1.969*	2.963**	0.862	8
3d.......	"	2-weeks	.232	-1.296	2.790	1.867	3.287*	0.946	3

consistent with the hypothesis that adjustments will be more pronounced as the time period considered increases. 16/

Any particular equation used for assessing pricing efficiency should be of the most logical mathematical form and also yield reasonably good statistical results. The linear equations (type 1) are not of the logically preferable form. The choice of equations, therefore, rests primarily between types 2 and 3.

Equations 3a and 3c were used in the text because they are of the most logical form, they yield reasonably high multiple correlation coefficients, and 3 of the 4 b-values are significant at the 99 percent level. Actually, however, there is little reason for choosing any one of these 8 equations in preference to the others. All yield substantially the same results.

Some caution, however, should be observed in using any of these equations to estimate the absolute change in shipping-point margins for given quality changes. Results will differ somewhat depending on the equation chosen. Table 12 shows changes in margins as estimated from each equation.

All equations show margins are inversely related to quality, a finding which tends to substantiate the hypothesis of a high level of pricing efficiency. With particular reference to equations 2b, 2c, 3b, and 3c, estimated changes in margins were generally within 0.25 cent to 0.5 cent of estimated changes in costs per pound for quality intervals of 80 to 40 percent. The 80 to 40 percent quality interval covers the majority of tomatoes packed in the Valley.

APPENDIX D

BASIC DATA ON COST ESTIMATES

Cost estimates presented in table 13 are based on a synthetic or model shed, built "on paper." They reflect a medium-size shed, operating a 200-hour season, in a building 38 x 105 feet in size, with manual dumping and packing, and automatic sizing, employing 54 shed laborers, and packing 100 percent of total output in 60-pound wirebound crates and 40-pound cartons.

The absolute amount of quality-associated costs is assumed to be unaffected by the level of operating efficiency, with the exception of cull disposal. Cull disposal costs are based on the assumption that culls are 35 percent of the total weight of all non-U.S. No. 1 tomatoes. Disposal costs are assessed at 0.1 cent per pound, an estimate determined from other research and data from 2 sample sheds. Total shed labor cost is based on an estimated wage rate of $1.21 per hour and a total labor input of 10,800 man-hours (54 workers times 200 hours). Variable repairs are estimated as 0.5 percent of replacement cost of equipment per 100 hours running. Electric power costs are estimated at 3 cents per kilowatt-hour, with an assumed consumption of 1 kilowatt-hour per horsepower per hour. Fixed annual charges are

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16/ The low correlations and smaller b_1 values in the daily equations (in comparison with longer time periods) actually are an important result in themselves. They tend to indicate that shippers are not as efficient in adjusting margins for day-to-day variations in quality as they are in adjusting to changes over longer periods. One possible explanation for this is that there may be a desire for reasonably stable prices and hence an unwillingness to make the greater fluctuations called for by daily adjustments to quality changes.

Table 12.--Estimated changes in costs and margins due to quality variations above and below 60 percent U.S. No. 1 grade, Lower Rio Grande Valley tomato market, 1961

Quality change from 60 percent U.S. No. 1 to the following percent U.S. No. 1	Changes in costs for plants with efficiency level of --			Change in margins estimated from equation:											
	Below $\bar{X}$	$\bar{X}$	Above $\bar{X}$	2a	2b	2c	2d	3a	3b	3c	3d	1b	1c	1a	1d
	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.	Cents per lb.
90	-0.45	-0.37	-0.25	-0.06	-0.39	-0.73	-0.80	-0.05	-0.22	-0.39	-0.38	-1.32	-1.83	-0.80	-1.68
80	-0.34	-0.28	-0.18	-0.05	-0.28	-0.52	-0.57	-0.03	-0.16	-0.28	-0.27	-0.88	-1.22	-0.53	-1.12
70	-0.20	-0.16	-0.10	-0.03	-0.15	-0.28	-0.30	-0.02	-0.09	-0.15	-0.14	-0.44	-0.61	-0.27	-0.56
60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
50	.28	.22	.13	.02	.18	.32	.37	.02	.10	.17	.17	.44	.61	.27	.56
40	.74	.54	.31	.05	.40	.73	.81	.05	.23	.43	.38	.88	1.22	.53	1.12
30	1.56	1.08	.56	.09	.68	1.24	1.38	.08	.39	.67	.65	1.32	1.83	.80	1.68

Table 13.--Quality-associated costs for a medium sized tomato packing shed for a 200-hour operating season, by quality and efficiency levels, Lower Rio Grande Valley of Texas, 1962

Item	Unit	Quality level (percent U.S. No. 1 grade)								
		90%	80%	70%	65%	60%	50%	40%	30%	20%
Percentage packout 1/	Percent	96.5	93.0	89.5	87.8	86.0	82.5	79.0	75.5	72.0
Total packout:										
Below average efficiency	60-pound equiv.	82,960	72,873	63,013	58,027	53,040	43,180	33,093	23,233	13,260
Average efficiency	do.	89,533	79,560	69,700	64,713	61,280	49,753	39,780	29,920	19,833
Above average efficiency	do.	105,513	95,540	86,680	80,693	75,707	65,733	55,760	45,900	35,927
Net output per man-hour:										
Below average efficiency	Pound	732	643	556	512	468	381	292	205	117
Average efficiency	do.	790	702	615	571	526	439	351	264	175
Above average efficiency	do.	931	843	756	712	668	580	492	405	317
Quality-associated costs:										
Cull disposal:										
Below average efficiency	Dollar	181	329	444	486	518	550	528	452	309
Average efficiency	do.	195	359	491	542	582	633	634	583	463
Above average efficiency	do.	230	431	603	676	739	837	889	894	838
Other 2/	do.	38,263	38,263	38,263	38,263	38,263	38,263	38,263	38,263	38,263
Total quality-associated costs:										
Below average efficiency	do.	38,443	38,592	38,706	38,749	38,781	38,812	38,790	38,715	38,572
Average efficiency	do.	38,457	38,622	38,753	38,805	38,845	38,896	38,897	38,845	38,725
Above average efficiency	do.	38,492	38,694	38,866	38,938	39,002	39,099	39,152	39,156	39,101
Quality-associated costs per 60-pound equivalent:										
Below average efficiency	Cent	46.32	52.98	61.44	66.78	73.14	89.88	117.24	166.68	290.88
Average efficiency	do.	42.96	48.54	55.62	59.94	65.16	78.18	97.80	129.84	195.24
Above average efficiency	do.	36.36	40.50	45.36	48.24	51.54	59.46	70.20	85.32	108.84
Quality-associated costs per pound: 3/										
Below average efficiency	do.	.77	.88	1.02	1.11	1.22	1.50	1.95	2.78	4.85
Average efficiency	do.	.72	.81	.93	1.00	1.09	1.30	1.63	2.16	3.25
Above average efficiency	do.	.61	.68	.76	.80	.86	.99	1.17	1.42	1.81
Change in total quality-associated costs per pound from 60 percent U.S. No. 1 grade										
Below average efficiency	do.	-.45	-.34	-.20	-.11	.00	.28	.74	1.56	3.63
Average efficiency	do.	-.37	-.28	-.16	-.09	.00	.22	.54	1.08	2.17
Above average efficiency	do.	-.25	-.18	-.10	-.06	.00	.13	.31	.56	.96

1/ Percent culls is equal to the percent packout subtracted from 100 percent.
2/ Total plant labor cost $13,068, various equipment and miscellaneous utilities $436, buildings and equipment $5,593, salaried labor and overhead $19,166.
3/ Quality-associated costs per 60-pound equivalent divided by 60 pounds. Figures may not always check out due to rounding.

based on an estimated total replacement cost of $22,025 for buildings and $26,205 for equipment. Replacement cost estimates were obtained from building contractors and packing equipment companies. Depreciation is based on a straight line method with an estimated life of 40 years for buildings and 15 years for most equipment. Interest is charged as 3.5 percent of replacement costs, fixed repairs at 1.5 percent on equipment and 1.8 percent on buildings, taxes at 1.0 percent, and insurance at 1.0 percent on equipment and .6 percent on buildings. Salaried labor and overhead include salaries for fieldmen, salesmen, clerical office workers, and administration of the shed.

Net output per man-hour is output per man-hour on the packing line, as presented in table 3 of the text, but with an arbitrary allowance of 10 percent for rest periods and minor work stoppages. Of the 54 total laborers in the shed, 34 would be on the packing line. The 10 percent allowance is probably close to the minimum, when "10 minute breaks" and the time lost in starting and ceasing operations is considered in addition to delay due to mechanical failure.

The level of quality-associated costs for any particular firm will probably vary somewhat from those presented in table 13, depending on differences in shed size and layout, containers packed, level of efficiency, and other factors. The model plant on which these cost estimates are based would, in comparison with firms operating in the Lower Valley, be classified as handling a medium to large volume of tomatoes.

A future report will contain more detailed information on shed layouts, operating methods, and costs for sheds of varying capacities.